

DIAGNOSIS AND TREATMENT OF OTITIS EXTERNA AND OTITIS MEDIA

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Probably one of the most common ailments of dogs seen in a veterinary practice is ear disease. From mild erythema to severe otitis media, approximately 15%-20% percent of all canine patients and approximately 6% - 7% percent of all feline patients have some kind of ear disease. In the humid climates, the incidence of otitis in dogs approaches 50%. It has been estimated that over half of dogs with chronic recurrent otitis externa have otitis media as well. Determining the cause of ear disease is often a difficult task.

OTITIS EXTERNA

Primary Causes of Ear Disease

Pets with itchy ears may not have ear disease seen on otoscopic examination at all, but may be responding to a localized pruritus associated with an underlying pruritic disease. Since many diseases found in the ear arise as a result of an underlying skin disease, the veterinarian should also do a careful evaluation of the pet's skin to determine the underlying etiology if possible. Often, diagnosis and treatment of the underlying skin disease diminishes the severity of ear disease.

Primary factors are those diseases of the skin that also have a direct effect on the skin that lines the ear canal. Diseases such as atopy, food hypersensitivity, parasites, foreign bodies, hypothyroidism and keratinizing diseases frequently result in ear disease.

Predisposing Causes of Ear Disease

Predisposing factors are those things that directly change the microclimate in the ear canal. The microclimate changes include increased temperature from inflammation, increased humidity from poor ventilation and stenosis, and changes in the composition of the cerumen. Certain breeds have more cerumen glands (Cockers, Labradors, and Springers) that favor yeast growth. Humid environments and excessive moisture in the ears from swimming or bathing promote bacterial growth. Excessive trauma to the ear canal resulting from exuberant ear cleaning or trauma from instruments used in the ear canal may allow bacterial colonization. Pathological alterations to the ear canal epithelium such as fibrosis or tumors allow colonization of bacteria and yeasts along the increased surface area. These pathological changes produce fissures and deep crevices where organisms are sequestered.

Perpetuating Factors

Perpetuating factors are those things that prevent normal resolution of ear disease. Bacteria, yeasts, exudates and secretions from otitis media, and contact allergies from drugs such as neomycin keep the inflammatory process going. They are not the reason for the initial onset of otitis, but until they are dealt with, the ear disease will continue. Overtreatment of ear disease with ear cleaners keeps the epithelium moist and macerated. Too short a treatment duration may not rid the ear of organisms. Inappropriate antimicrobial therapy may be totally ineffective, i.e. treating an ear with yeasts by using an antibiotic.

To illustrate the interaction of these factors, consider a dog with atopy that may show inflammation of the ear canal resulting in redness, swelling, heat, and pain. The atopy is the **primary cause** of ear disease. In fact, almost 80% of atopic dogs have otitis externa. In a cylindrical cartilage tube, such as the ear canal, inflammation decreases the lumen diameter, which tends to decrease the ventilation and drying of the ear canal. Without ventilation, the humidity level of the ear canal increases. The resulting stenosis and increased humidity are **predisposing causes**. Humidity is a factor favorable for bacterial growth. The bacterial otitis externa then becomes a **perpetuating factor** and the symptoms of ear disease will not diminish until the bacterial component is removed. However, the underlying cause of the ear disease, atopy, remains in spite of the elimination of the bacterial infection.

Dermatological conditions often affect the ear canal, making it susceptible to otitis externa. Examples of primary skin diseases that may also affect the ear canal include juvenile cellulitis, autoimmune diseases such as pemphigus and systemic lupus erythematosus, keratinization disorders, and erythema multiforme (a systemic drug reaction). The ear canal is an invagination of epidermis forming a hollow skin tube in the inside of the head which begins at the eardrum. Pathological mechanisms affecting the skin of the animal have the same effect in the epithelial tube lining the ear canal. Not all cases of otitis externa are infected with bacteria or yeasts and it is a challenge for the clinician to seek out **these cases** and to treat them appropriately.

THE 4 STEP APPROACH TO OTITIS EXTERNA

1. Examination of Skin and Ears

It is always important to look at the overall patient. Checking the skin for problems may alert the clinician to potential primary causes for the ear disease. Classic signs of atopy may be noted or there may be symmetrical alopecia suggesting hypothyroidism. Then the ear canal should be examined for exudates, growths, or other pathological changes. The eardrum should always be evaluated because the choice of medications and flushing agents will depend on the integrity of the eardrum.

2. Cytological Evaluation of Otic Exudate

The next step in approaching ear disease is examining a cytologic preparation of the otic exudate. Cytological examination of every infected ear should be done routinely.

A sample is obtained with the use of a small tipped cotton applicator. The swab is placed through a disinfected otoscope cone placed into the vertical ear canal near the junction with the horizontal canal. The swab is extended beyond the plastic cone and pressure is applied to the ear canal epithelium as the swab is withdrawn back through the cone. In this manner, packing of wax and exudate is minimal. Every attempt is made to sample only from the horizontal canal epithelium because the vertical canal is often contaminated with a number of commensal organisms unrelated to the ear disease.

The swab is then rolled onto a new, clean microscope slide by rolling the harvested material from the left ear on the left side of the slide and the swab from the right ear on the right side of the slide. The slide is labeled with the patient's name and the date of the sample. The slide is heat fixed and stained with blood stain (Diff-Quick or Wright-Giemsa). After the slide is dried, a drop of slide mounting medium is applied and a coverslip placed over the material. In this manner a permanent slide is made. A drop of mineral oil can be spread on the stained slide and a coverslip placed over the oil if permanent slides are not desired. This standardized approach to making slides allows uniform identification of organisms from each ear and allows comparison of ear cytology from visit to visit.

To look for ear mites under the microscope, the ear swabs are rolled in a drop of mineral oil on a microscope slide and coverslipped. Low power (40X-100X) examination reveals mites crawling across the field and/or the typical oblong dark brown *Otodectes* eggs may be seen.

Evaluation of slides should begin with a low power (100X) overview of cell types. If there are large numbers of epithelial cells and few microorganisms, then noninfectious causes of otitis such as seborrheic diseases and hypothyroidism should be considered. Sheets of epithelial cells may indicate neoplasia as the cause of otitis externa and the presence of numerous intact non-staining epithelial cells may indicate a seborrheic condition. Inflammatory cells and acantholytic cells may indicate autoimmune disease. High power (400x) examination is needed to characterize bacteria and yeasts. Large numbers of bacteria and/or yeasts indicate secondary invaders. When neutrophils are seen in addition to bacteria or yeasts, deep infection must be considered. Ear mites are not often seen on stained ear swabs, but the eggs may be found on mineral oil preparations.

When infectious organisms are seen on high power (400X) cocci are usually *Staphylococci*, rods are usually *Pseudomonas* or *Proteus*. Budding yeasts of *Malassezia* may be seen individually in the background on a roll smear, but large numbers of yeasts colonizing on exfoliated epithelial cells are indicative of secondary yeast infection. *Staphylococci* and *Malassezia* are often found together in the same ear, and there is evidence to suggest that *Malassezia* growth is stimulated by *Staphylococci*.

3. Flushing the Ears

After the class of disease and the type of infection is determined, the next step is to sedate or anesthetize the animal so that a thorough flushing and suctioning of the ear canal can be done. It is imperative that exudates and dried medications that have accumulated in the ear canal are removed so that the canal epithelium can be evaluated. Good visualization of the ear canal after flushing helps to insure that the vertical and horizontal canals are clean and free of debris. The efficacy of otic medications is enhanced when they are applied directly onto the cleaned epithelial surface.

Care must be taken in the selection of a flushing agent, since so many ear cleaners contain materials that are potentially ototoxic when the eardrum is not intact. Prior to using an ear cleaner, read the label to see if it can be used if the eardrum is damaged. Many manufacturers are now placing a warning on their labels.

With so many products available to veterinarians for ear care, it is important to understand that these products often fall into one of three categories. Cerumenolytics emulsify ear wax for easy removal. Ear flushes aid in removing pus, mucus and serum from the ears. Drying agents decrease moisture in the ears and dessicate the surface keratinocytes. Moisture is a predisposing factor allowing growth of organisms in the ear canal.

Until a determination of the integrity of the eardrum is made, the choice of flushing solutions should be limited to non-detergent, non-alcoholic type of flushing solutions. Physiologic saline and dilute povidone iodine are safe flushing materials to use. When used as warm solutions (98 degrees F.) these solutions act to soften wax and loosen other debris.

Ear curettes are useful for scraping the ear canal to dislodge large pieces of wax and epithelial shreds. They are available in various loop sizes and angles and some have a circular cutting surface (Dermal Curettes). Curettes are also useful for harvesting cells for cytology when a tumor mass is suspected.

Organisms found as perpetuating factors of otitis externa include bacteria and yeasts. *Malassezia*, *Staphylococci*, and *Pseudomonas* are the most common organisms isolated from the ears of dogs. *Corynebacteria*, *Enterococci*, *E.coli*, *Streptococci*, and *Proteus* are also frequently isolated. *Malassezia* is often found in the ears of cats, but cats rarely have bacterial ear infections. *Demodex* mites can also be isolated from ceruminous otitis cases. The prevalence of one organism over another is determined by a variety of factors. For example, excessive cerumen production by cerumen gland hyperplasia permits *Malassezia* growth, while decreased immune function seen with hypothyroidism allows colonization of *Staphylococci*. Dogs that swim and get water in their ears are much more prone to *Pseudomonas* infections.

4. Guidelines for Treatment of Otitis Externa

A treatment plan be formulated that is tailored specifically to the patient after the skin and ears are evaluated, the cytology is done, and the ear canal is cleansed.

Corticosteroids have a definite place in the treatment of otitis externa. Systemic corticosteroids reduce the intense pruritis associated with acute otitis externa and reduce the inflammation in the epithelium of the ear canal. Systemic high doses of corticosteroids (1mg per pound Prednisone orally daily) are used for several days to reduce the edema and stenosis that prevents adequate examination of the ear canal. Dexamethasone injection given at a dose of 0.1mg per pound also helps decrease otic inflammation with less side effects. If the ear canal is patent, then a potent topical corticosteroid such as dexamethasone, betamethasone, or fluocinolone may be used to relieve the intense pain and itching. A relatively new corticosteroid, mometasone (Mometamax, Schering), has been introduced to decrease the systemic effects of topical otic corticosteroids.

As the otitis resolves, a less potent corticosteroid such as 1% hydrocortisone may be used in the ear to act as a preventative for inflammation in atopic dogs that may have recurrent otitis. Corticosteroid ear drops do not remove hyperplastic epithelium or glands, so if there is no response to high dose corticosteroids after 7-10 days, the stenosis is probably the result of increased tissue growth rather than inflammation.

Another approach to treat a stenotic ear with steroids is the use of an ear wick. The dehydrated, compressed polyvinyl alcohol wicks have a sponge like architecture. A dry ear wick (Ultracell) can be placed into the stenotic ear canal and then moistened with an aqueous steroid several times daily. The moistened wick will swell to many times its dry diameter and will form fit to the ear canal. These wicks may be purchased to achieve either a 7mm or a 9mm hydrated diameter. In this manner, the corticosteroid medication will be in constant contact with the ear canal. It is left in for 2 weeks and then removed. Often the hyperplasia and inflammation will decrease appreciably, increasing lumen diameter.

Antibiotics that kill *Staphylococci*, *Pseudomonas* and other gram negative bacteria are used in many otic preparations. Although antimicrobial therapy may temporarily relieve the symptoms of otitis externa, the symptoms may re-occur unless the underlying disease is identified and treated as well. These infectious organisms are considered to be perpetuating factors in ear disease.

Topical otic formulations are made with combinations of pharmaceuticals such as antifungals, corticosteroids, insecticides, and topical anesthetics. First line antibiotics such as gentamycin, amikacin, neomycin, and polymyxin B are potentially ototoxic, so if there is no tympanic membrane (TM), these antibiotics should be avoided. In addition, neomycin has been implicated as a sensitizer in contact dermatitis in the ear. If the ear becomes worse with neomycin treatment, the antibiotic should be stopped immediately. Tobramycin (0.3% ophthalmic drops) is safer to use instead of other topical aminoglycosides if the status of the TM is unknown.

Baytril Otic (Bayer) is a solution that contains 0.5% enrofloxacin and 1% silver sulfadiazine. The high concentration of enrofloxacin has been demonstrated in-vitro to provide a high enough concentration to be effective against most bacteria. However, there are a number of fluoroquinolone resistant *Pseudomonas* bacteria being found, and so this product is not recommended for first-line use in *Pseudomonas* infections. Enrofloxacin may not have a good sensitivity against *Streptococci*. It's use should be based on demonstration of susceptibility of the organism to enrofloxacin. Silver sulfadiazine may have some use against the yeasts in the ear.

Treatment of chronic *pseudomonas* otitis cases may require some unstable, unique antibiotics such as ticarcillin or ceftazadime injection mixed up for topical otic use. The author uses Ceftazadime (Fortaz, Sandoz) at a concentration of 50 mg/ml as an ear drop.

Systemic antibiotics may be useful in some suppurative otitis externa cases as an adjunct to ear cleansing and topical antibiotic therapy. Culture and sensitivity should be reserved for those otitis cases that are unresponsive to topical therapy because the sensitivity results are often misleading, since they are based on BLOOD levels, not topical levels. If there is severe inflammation with inflammatory cells present on otic cytology, then using intracellular antibiotics like fluoroquinolones, azithromycin, or clindamycin may increase the success of systemic treatment by delivering the antibiotic to the site by these cells.

Another useful compound as an adjunct in Gram negative ear infections is tris-EDTA solution (TrizEDTA, Dechra). EDTA chelates metal ions, such as calcium and magnesium, which are necessary to maintain the integrity of the cell membrane. The cell membrane of these bacteria becomes more porous so that the antibiotic can diffuse into the bacteria

and kill it. Tris buffer keeps the ear canal at pH of 8.0, which is optimum for function of the aminoglycosides and fluoroquinolones. Tris-EDTA alone has been shown in vitro to have potent bactericidal effects. It has also been shown to irreversibly bind to the destructive elastase enzyme released from gram negatives. Clinically, tris-EDTA is used as a pre-treatment flush in the external ear 5 minutes prior to the instillation of topical antibiotics. Usually treatment is done on a twice daily basis. Because of the high pH of tris-EDTA, *Malassezia* infections may worsen when tris-EDTA is inappropriately used in this infection.

Ear mite treatment can be done using selamectin (Revolution, Pfizer) twice a month or injectible cattle ivermectin (0.1 cc subcutaneously every 2 weeks). In young kittens otic 0.01% ivermectin (Acarexx, Idexx) or 0.1% milbemycin (Milbemite, Novartis) are safe to use. Many topical ear mite drops containing insecticides are also available for ear mite treatment.

Alterations in cerumen lipid composition caused by underlying skin diseases such as food sensitivities, atopy or hypothyroidism may play a role in *Malassezia* otitis externa. Low levels of free fatty acids in surface lipids coupled with increased levels of surface triglycerides favors *Malassezia* infections. Diseases of the ear cause increases in the amount of sebaceous secretion and increases in the number and amount of lipid secretion from the apocrine (cerumen) glands. It has been shown that over 50% of atopic dogs have elevated *Malassezia* populations on their skin.

To remove these lipid substrates from the ear and to treat otitis externa complicated by *Malassezia*, the author prefers to clean the ear in the hospital first and then the home use of an acetic acid/boric acid solution with ketoconazole and hydrocortisone (Malacetic Ultra Otic, Dechra). Acetic acid degreases the ear canal and boric acid keeps the epithelium relatively dehydrated. A topical solution of miconazole or clotrimazole may be used in the ear canal after cleaning. In addition to ear cleaners, systemic oral ketoconazole or itraconazole are useful for refractory yeast otitis cases or for yeast otitis cases where there is also stenosis. These systemic compounds may reduce the pruritis associated with the yeasts, but they have not been shown to reduce otic yeast numbers.

In mild cases of *Malassezia* otitis externa, the external canal can be cleaned by the owner at home to facilitate removal of excessive exudate accumulation associated with otitis externa/media. The ear cleaner or flush is used daily for 7-10 days by filling the ear canal to overflowing, massaging the base of the ear, and allowing the solution to remain in the ear canal for 5 minutes. The loosened debris is wiped off of the concave pinnal surface with a dry cotton ball. This procedure is repeated once daily. When the ear canal is clean, the cotton ball will remain fairly white when the solution is wiped away. At that time, home ear cleaning is reduced to once weekly.

OTITIS MEDIA

Otitis media, an inflammatory disease in the middle ear cavity, is a common disease process that goes unrecognized in most veterinary practices. Otitis media in dogs is much more prevalent than previously thought. In dogs, secondary otitis media occurs in approximately 16% of acute otitis externa cases and as many as 50% to 80% of chronic otitis externa cases.

The fact that otitis media is present in over half of canine patients with chronic otitis externa should stimulate a reformulation of the thought process when faced with these cases. Just the common history that the patient has been treated repeatedly for ear infections should alert the veterinarian to think about otitis media as a possibility. Otitis media should also be considered when presented with a patient showing any neurological disease affecting the head including vestibular disease, Horner's Syndrome, or facial nerve damage.

The diagnosis of otitis media in dogs can be quite difficult to make owing to the long, bent, funnel shaped conformation of the dog's ear canal, which makes it hard to see the tympanic membrane (TM). In addition, many patients with otitis media have an intact TM giving the clinician the impression that there is nothing wrong in the middle ear. Most canine patients with otitis media also have a chronic otitis externa with pathological changes to the ear canal that cause stenosis, making visual examination of the TM impossible. It is often theorized that otitis media is an extension of otitis externa that was either not treated, improperly treated, or resistant to treatment. The end result is significant damage resulting in porosity to the eardrum over time.

In cats, the diagnosis of otitis media in cats may be easier to determine with the otoscope due to their relatively short ear canals. Otitis media in cats most often results as a sequella to respiratory disease, so a history of sneezing, ocular discharge and/or nasal discharge may aid in providing a clue. Some cats with otitis media also have a visible polyp in the ear canal after the ear is cleaned of the dried exudates and mucus. Many feline otitis media cases have a dark, dried, crumbly exudate in the ear canal that mimics an ear mite infestation.

Primary Otitis Media in the Cat

In the cat, primary otitis media occurs as a result of infection ascending through the eustachian tube to the middle ear. An exact mechanism for the development of otitis media in the cat has not been reported, although the bacterial isolates from the bullae of cats with middle ear disease are consistent with respiratory pathogens. It has been hypothesized that chronic viral upper respiratory infection early in life may play a role in initiating otitis media in cats, since these infections and polyps occur in younger cats. However, this has not been documented with virus isolation studies.

In one study, tissues from inflammatory polyps were assayed for feline calicivirus and feline herpesvirus-1 by PCR. Failure to detect either of these viruses suggests that persistence of these viruses is not associated with the development of inflammatory polyps. However, the presence of these viruses may change the ability of the auditory tube to protect the bulla from infection with other agents.

In many species, including man, rats, pigs, and cattle, *Mycoplasma* has been reported as an inducing agent in middle ear disease. In addition to the more common *Streptococci* and *Staphylococci* isolated from clinical feline otitis media cases, organisms much more difficult to culture and identify such as *Mycoplasma* and *Bordetella* have also been cultured from the middle ear of cats with otitis media. It is unclear what role these upper respiratory bacteria may play in the pathogenesis of feline otitis media. It is also unclear whether anaerobic organisms may be involved when the eardrum is intact and the auditory tube swells thus sealing these bacteria within the bulla. Often, cultures and/or cytology do not reveal an infectious organism. This raises the question of whether allergy, viruses and/or fungi have a role in feline middle ear disease.

Secondary Otitis Media in Cats

The cat can have a secondary otitis media as a result of eardrum damage from ear mites or extension of a polyp through the TM. Nasopharyngeal or inflammatory polyps originate from the middle ear mucosa. A polyp is a pedunculated, protruding growth that results from chronic inflammation. Depending on their growth pattern, they can grow through the auditory tube toward the nasopharynx or they may grow through the tympanic membrane. When found in the external ear canal, the enlarging polyp mass has created a permanent opening from the external ear canal to the middle ear. Usually the presence of a polyp is associated with secondary bacterial otitis media. There is copious mucus and pus produced in these cats. When examined, the external ear canal may show liquid exudates or there may be the presence of a wax covered mass at the eardrum. Flushing the ear canal thoroughly reveals the fleshy pink to red polyp protruding into the ear canal.

Secondary Otitis Media in Dogs

Exudates and infectious organisms drain into the middle ear from the external ear canal through an eroded or ruptured eardrum and get trapped in the ventral portion of the bulla. Once the medications, chemicals in ear flushing products, and/or debris contained within the external ear canal enter the middle ear through an eroded eardrum, tissue reaction of the respiratory epithelial lining of the middle ear begins. This is called secondary otitis media.

The pathogenesis of secondary otitis media in the dog is complex and often multifactorial. Due to the "L" shaped configuration of the canine external ear canal, proteolytic enzymes within exudates produced as the result of otitis externa accumulate against the thinnest portion of the eardrum. The resulting inflammation and enzymatic destruction leads to necrosis of the epithelium and supporting collagen, which results in thinning of the tympanic membrane causing it to weaken.

Ulceration along the ear canal can extend to the eardrum. The ulcerated tissue leaks serum, which can cause maceration and excoriation of the epithelium. Liberation of bacterial proteases, collagenases, elastases, lysozymes from phagocytic cells, and the epidermal maceration resulting from the excessive amount of serum in the ear canal disrupt the epithelial layers of the ear canal and can lead to either erosion or rupture of the eardrum.

Many cases of acute otitis media can be prevented. Special care in cleaning and attention to fluid pressure especially with the use of bulb syringes used to flush the external ear canal can prevent the high pressure from causing an iatrogenic rupture. Removal of exudates by careful flushing and suctioning of the ear canal eliminates the source of destructive enzymes acting on the eardrum. Specific therapy for infectious organisms based on cytology or culture results can shorten the course of the bacterial or fungal disease. Treatment of underlying skin disease such as atopy, food allergy, and hypothyroidism may remove or improve primary causes of otitis externa. Proper client education concerning the chronic nature of ear diseases increases owner compliance in allowing frequent rechecks to follow the progress of treatment. Recheck visits allow the veterinarian to examine the eardrum and to make changes in the treatment protocol when therapeutic response is inadequate.

Whether primary or secondary, the resulting inflammation causes the lining epithelium, called the mucoperiosteum, in the bulla to change from cuboidal to pseudostratified columnar ciliated leading to an increase in the number of secretory cells and glands, further adding to the quantity of exudate. Chronic inflammation leads to mucosal ulceration and breakdown of the epithelial lining. The lamina propria thickens in response to inflammation and as vascularity increases, edema and granulation tissue form. As otitis media becomes more chronic, the lamina propria changes to dense connective tissue and bone spicules may develop within it. Radiographic thickening of the tympanic bulla becomes apparent.

The cycle of inflammation, ulceration, infection, and granulation tissue formation may continue, destroying the surrounding bone. For example, septic arthritis of the ossicles may cause pain and decreased hearing owing to the fusion of these joints. The normal air conduction of sound waves is prevented and the patient may suffer decreased ability to detect high pitched sounds. With time, the ossicles are dissolved from osteomyelitis and irreversible hearing deficit occurs.

Exudates and secretions formed in the bulla escape into the external ear through the ruptured eardrum and contribute to the exudate already present in the external ear canal. This large amount of liquid fills the ear canal and

overflows onto the pinna when the patient shakes its head. If there is a polyp or tumor blocking the outflow of secretions and exudates from the middle ear, significant quantities of inspissated material can be present when the obstruction is removed.

A fluid pressure gradient created by suppurative otitis media and increased mucus secretion prevents the eardrum from completely sealing. As the fluid pressure increases within the bulla, it is pushing against a healing eardrum with a very thin, tenuous covering. The pressure allows fluid to escape through the path of least resistance and a small hole remains in the TM. As long as there is a hole in the eardrum, this condition remains in a state of flux; i.e. fluid can enter or leave the bulla, carrying infectious materials and exudates in both directions.

When the amount of middle ear secretion and exudate is decreased, when the infection is controlled by therapy, and when the fluid pressure is decreased, the eardrum can heal and otitis media is resolved. Sometimes, however, the eardrum seals but the infection is not completely resolved. If the trapped organisms lead to a return of inflammation and secretion, the eardrum can once again bulge and/or rupture. Patients with otitis media may have had a history of repeated episodes because of this alternating rupture of the TM and subsequent healing. A report by Cole, et. al. demonstrated that 70% of eardrums in documented cases of canine otitis media were intact.

History and Clinical Signs of Otitis Media

It is uncommon for a patient to present to the veterinarian with a history of acute otitis media. However, iatrogenic rupture of the eardrum during ear cleaning can lead to an inflammatory acute otitis media. A foreign body that has become lodged in the ear canal can also cause acute otitis media. For example, plant awns and foxtails often work their way through the eardrum and cause a considerable bacterial infection and inflammatory reaction in the ear canal and bulla.

More commonly, a dog with otitis media will have the history of recurrent or chronic bacterial external ear infections. The mucous membrane lining the tympanic bulla reacts to foreign substances (e.g. infectious organisms, hairs, cells, irritating medications and chemicals, and other foreign material) by producing a purulent exudate and increasing secretion of protective mucus from activated goblet cells. Dogs and cats with otitis media with an open eardrum often have a copious, malodorous liquid discharge present when the ear canal is examined with the otoscope. Additionally, it is common to see copious mucoid exudate along the floor of the horizontal canal. Although this material is usually in liquid form, the mucus and pus may be inspissated and dry. Mucus is not produced anywhere along the external ear, but it oozes from the tympanic bulla into the horizontal canal through any rent in the tympanic membrane. The presence of mucus means that there is a hole in the eardrum.

Some patients will produce so much exudate that it will overflow onto the periaural region of the face or in a dog with pendulous ears, there will be dried exudate on the ear flap adjacent to the external opening of the auditory canal. Head shaking to relieve the pain and tickle associated with liquid exudate is very common in otitis media. It may be wise to check for otitis media in cases of aural hematoma.

Pain on palpation of the base of the ear canal or pain on manipulation of the pinna should also alert the clinician to otitis media. Some dogs will even bite their owners while they are trying to administer medication because of the intense pain. Patients with otitis media may also be reluctant to have their mouth opened and there may be a history of reluctance to chew hard food. This is due to inflammation, swelling, and pain within the bulla, which is located adjacent to the temporomandibular joint.

When otitis media affects the nerves that course around the base of the ear or through the tympanic bulla, the patient may show something as subtle as keratoconjunctivitis sicca on the ipsilateral side. This results from damage to the palpebral branch of the facial nerve. When otitis media affects the sympathetic nerves from the facial and trigeminal nerves coursing through the middle ear, the patient may show mild signs of Horner's syndrome (enophthalmos, ptosis, and miosis). Some patients may show pain, head tilt, or, with facial nerve palsy, a drooped lip, drooped ear, or loss of the ability to close the eyelid leading to exposure keratitis. Since the facial nerve courses in and around the ear canal, it is easily affected by swelling, inflammation, and trauma from the dog scratching at the base of the ear. Facial neuropathy should be suspected if there is drooping of the facial muscles and skin or drooling saliva because the lips and facial muscles cannot create an oral seal. Peripheral vestibular disease with or without nystagmus and circling may be present if inflammation and infection have affected the inner ear.

An owner may present a patient for a hearing deficit. These cases should be evaluated for otitis media. Fluid in the middle ear dampens hearing. If this fluid is the result of previous flushing, it is usually absorbed within 7-10 days and the patient will regain the hearing. When the eardrum is ruptured or when the ossicles of the middle ear have sclerosed, air conduction hearing is reduced. High-pitched sound waves cannot be effectively transmitted from the ear canal to the cochlea. If a tumor or a polyp has filled the middle ear, air conduction hearing is eliminated. Bone conduction hearing is usually still present in these patients, and the pet can only hear the lower range of tones (bone conduction hearing can be demonstrated by placing your fingers in your ears and listening to the sounds around you). If there is hearing loss detected, this is usually as a result of bilateral ear disease. Unilateral hearing loss is difficult to assess in animals.

If there is pharyngeal drainage of mucus and exudates resulting from otitis media, the patient may be presented for inspiratory stridor. In these cases, a pharyngeal examination may reveal a nasopharyngeal polyp interfering with breathing or thick mucus draining from the auditory osteum in the nasopharynx covering the caudal pharynx occluding the airway.

Evaluation of the Patient

Careful examination of the TM in the dog or cat with otitis media requires general anesthesia. It is recommended that the patient have an endotracheal tube placed in case there is a ruptured eardrum. Manipulation or flushing can cause material to drain through the eustachian tube into the nasopharynx resulting in aspiration.

If there is significant stenosis of the external ear canal, either from inflammation or from permanent pathological changes to the ear canal, the eardrum may not be adequately visualized. Patient preparation using potent topical and/or systemic corticosteroids (prednisone – 1mg/lb daily for 10-14 days then taper or dexamethasone 2mg/ml at a dose of 0.1 mg/lb IM once) may be needed to reduce otic inflammation and allow examination of the TM on a subsequent visit. An ear wick can be placed into a stenotic ear and with daily application of a steroid; the wick will keep the steroid in contact with the epidermis. After 2 weeks of treatment, the wick can be removed, often relieving the stenosis. If permanent changes to the ear canal prevent visual determination of the integrity of the eardrum, other techniques are used to identify disease proximal to the stenosis.

Recently, with the introduction of video otoscopes, it is possible to get a very detailed, magnified examination of the ear canal and the eardrum. The video otoscope provides excellent lighting at the tip of the tapered probe by transmitting light through the probe by a fiberoptic cable attached to a high output light source. Once the veterinarian is comfortable looking at normal eardrums: the location, color, clarity and the normal tension on it, then using the TM to diagnose otitis media becomes much easier. If the eardrum remains translucent, the middle ear can be transilluminated with the bright light from the video otoscope and the contents of the middle ear can be visualized.

In obvious cases of canine otitis media, there is no eardrum present. The ear canal is filled with a liquid secretion, often with flecks of material mixed with it. A mucus-filled ear canal may alert the clinician to otitis media. Most patients with chronic otitis externa that has been present for 45-60 days will have a coexisting otitis media. In otitis externa, purulent exudates and proteolytic enzymes elaborated by inflammatory cells have a caustic effect on the thin epithelium of the eardrum, causing it to become necrotic, weaken and eventually rupture. When this happens, hairs, ceruminous secretions, exudates, and infectious bacteria or yeast organisms in the external ear move into the middle ear. In these patients it is difficult to visualize any part of the eardrum since it may not be present at all. Sometimes, only a small ring of granulation tissue may be seen at the annulus fibrosus where the eardrum attaches to the ear canal. That is where the eardrum was attached. With the otoscope, an otitis media case without suppuration will look like a deep dark hole. The mucosa becomes dark as it becomes hyperemic and brownish ceruminous exudates and even dried blood fill the bulla.

In some cases of otitis media, the eardrum is intact but it may look abnormal. It may change color in response to inflammation on the medial side, becoming opaque and gray in color, rather than pearly and translucent. Sometimes there is fluid behind the eardrum and examination of the intact TM may indicate that it is bulging into the external ear. Purulent material in the middle ear may be seen as yellow fluid behind the eardrum. Early polyps and tumors in the middle ear may be seen as fleshy masses through the eardrum. Therefore, the presence of an eardrum does not rule out otitis media, particularly in dogs with chronic otitis externa. These dogs may have had a ruptured eardrum that healed, trapping bacteria and yeast in the tympanic bulla.

Is the Eardrum Ruptured?

Several techniques have been described to determine the integrity of the TM when it cannot be visualized in an ear with a stenotic external ear canal. A small diameter 3 ½ Fr. to 5 Fr. catheter can be inserted into the ear canal until it stops. It is then extended and retracted to get a feel for the rigidity of the "stop." If there is a spongy feel, the eardrum is intact. If there is a definite hard feel to the "stop," the eardrum is ruptured and the catheter is hitting the medial wall of the tympanic bulla. This technique should be practiced on cadaver specimens to acquire the sensitivity.

An easy, indirect method for determining the integrity of the eardrum is to infuse warmed very dilute povidone iodine solution (or dilute fluorescein solution) into the ear canal with the anesthetized dog or cat in lateral recumbency. If the orange or yellow-green flushing fluid comes out of the nose or if the patient snorts out this solution through the oropharynx when pressure is applied with the flushing fluid, the eardrum is ruptured. The fluid has flowed from the external ear canal through the ruptured eardrum, into the tympanic bulla, and through the auditory tube into the nasopharynx.

Another technique is to place the patient in lateral recumbency with the suspected ruptured eardrum up, then fill the ear with warmed saline and insert the tip of the video otoscope into the ear canal. By looking through the clear fluid, if air bubbles rise from the ear canal while the animal breathes, then the eardrum is ruptured. Air from the nasopharynx rises through the auditory tube into the tympanic bulla to escape from the middle ear through a ruptured eardrum.

Myringotomy

To diagnose patients with otitis media it is sometimes necessary to perform a myringotomy to get a cytology specimen and to allow for culture and antibiotic sensitivity testing on the material trapped behind the eardrum. If there is fluid pressure pushing on the eardrum or negative pressure retracting the eardrum, perforation of the eardrum using a controlled myringotomy incision will immediately relieve the intense pain associated with these pressure changes.

To perform a myringotomy, the patient is anesthetized and the external ear canal is thoroughly cleaned with a disinfectant such as dilute povidone iodine. The ear canal is then dried using suction. A sterile rigid polypropylene catheter is cut to a 60 degree angle with a surgery blade to provide a sharp point. A long spinal needle can also be used to puncture the eardrum. The tip of the cut catheter is advanced under good visualization and the *pars tensa* is punctured at either the 5 o'clock or 7 o'clock position in order to remain away from the germinal epithelium and blood vessels overlying the manubrium of the malleus.

Alternatively, a small Buck curette (2mm) can be used to make a hole in the eardrum. This instrument makes a larger hole in the eardrum and is more difficult to accurately direct to the proper site for puncture. This technique may be used to create a large hole in the eardrum to allow middle ear exudates to drain into the horizontal canal and to prevent pressure gradients from re-occurring. Larger instruments used for myringotomy cause tearing of the eardrum and should not be used.

Many veterinary practices are using CO2 lasers to make the myringotomy incision. A 0.8mm X 180 mm rigid tip or a long, flexible Teflon tip can be inserted through the working channel of the Video Vetscope and can be advanced to the eardrum. Applying a pulsed, low wattage (3-4W) laser impulse melts the eardrum. The advantage of laser myringotomy is that the tip does not have to touch the eardrum, so there is less chance of contamination of the bulla with external ear canal material. In addition, the hole made by the laser is circular and takes longer to heal, which is sometimes beneficial in providing drainage.

Fluid under pressure may freely flow into the horizontal canal as the perforation begins and it should be suctioned to insure that the myringotomy incision is large enough to accommodate a 3 ½ Fr. or a 5 Fr. catheter. In the case of suppurative otitis media, myringotomy serves to decrease the fluid pressure behind the eardrum. The fluid escapes into the external ear canal and may continue to drain for several days, so during therapy the ear canals need to be flushed to remove this debris. The catheter is advanced through the incised TM, directed ventrally into the bulla and gentle suction is used to retrieve any material within the bulla. If a spinal needle was used, the stylet is withdrawn prior to suctioning. If the bulla is dry, 1 or 2 cc of normal saline can be infused into the bulla and then immediately retrieved. This material is submitted for cytology, bacterial culture and antibiotic sensitivity.

Ototoxicity

When the eardrum is perforated or totally absent, topical medications and the chemicals used in ear cleaners can gain access to the inner ear via the round and oval windows resulting in neurological ototoxicity. In addition to topical ototoxicity, many pharmacologic agents are ototoxic when administered parenterally. Careful consideration should be given to the ingredients contained in ear flush products and topical or systemic medications prior to their use. Many manufacturers of otic products are now putting warnings on the label of these products that their use should be avoided if the eardrum is not intact.

Ototoxicity results from damage to the hair cells either in the cochlea and/or in the vestibular apparatus. This results in hearing deficits, vestibular disease or both. Overt deafness or severe clinical vestibular disease (nystagmus, head tilt, and circling) may be obvious. However, subtle changes in either hearing or balance may not be detected by the owner or the veterinarian.

Many ear cleaning solutions contain a mixture of ototoxic substances that may gain access to the inner ear resulting in alterations of vestibular and cochlear function. Of these compounds, chlorhexidine is probably the most toxic, especially in cats. Severe, prolonged vestibular signs can be caused by chlorhexidine and its use in ears is strongly discouraged.

The aminoglycosides, especially gentamycin and neomycin, polymyxins, detergents, and most alcohols routinely used in the treatment of the external ear canal are known to be toxic to the nervous structures of the inner ear. Potentially ototoxic antimicrobial pharmaceuticals are present in most topical formulations for treatment of otitis externa. An assessment of the risks of topical use of a drug or ear flush solution that may cause ototoxicity versus the therapeutic benefit must be considered when using these formulations to treat otitis media. For example, the aminoglycoside tobramycin has shown to be an effective antibiotic for many multidrug resistant *Pseudomonas* organisms. Although it is an aminoglycoside with potential ototoxic side effects, it is often infused into the bulla to treat the bacterial infection because of its efficacy.

Many common topical antibiotics can cause ototoxicity. Gentamicin, for example, concentrates in the hair cells of the organ of Corti in the cochlea when administered parenterally. However, it may also cause vestibular signs when administered topically in the middle ear. The cell permeability is altered so the hair cells swell and become deformed. They are rendered rigid and are unable to respond to movements of the endolymph within the semicircular canals. Ataxia, head tilt and circling can result. A similar situation occurs in the cochlea when neomycin or kanamycin concentrate there. The cochlear nerve cells are damaged and cannot respond to vibrations, leading to hearing loss.

There is a very short list of products that can be infused into the tympanic bulla without the risk of ototoxicity. Prior to selecting a product to use in the bulla, a study of the ingredients contained in the preparation should be evaluated to determine the ototoxic potential. For antibiotics, the fluoroquinolones (ciprofloxacin, enrofloxacin, and ofloxacin), aqueous Penicillin G, some semi-synthetic penicillins (carbenicillin and ticarcillin), and some cephalosporins (ceftazidime and cefmenoxime) are safe to use in middle ear disease. A new cephalosporin ceftazadime (Fortaz, Smith-Kline-Glaxo) is being used topically for resistant *Pseudomonas* infections. The antifungals clotrimazole, miconazole, nystatin, and

tolnaftate can be safely infused. The aqueous forms of the anti-inflammatories dexamethasone and fluocinolone are safe in the middle ear. Most cerumenolytics cannot be used in the bulla. The exception is squalene (Cerumene, Evsco), which has been shown to be safe. Tris-EDTA is also a safe flushing agent.

Treatment of Otitis Media

Planning treatment of otitis media requires a stepwise protocol for maximal effect. An organized approach allows the clinician to formulate treatment or change existing treatment based on observations. The steps outlined below provide a framework for treating otitis media.

1. Access middle ear
2. Cytology and bacterial culture
3. Flush bulla
4. Infuse topical medications into the bulla
5. Reduce inflammation w/corticosteroids
6. Systemic and topical antimicrobials
7. Recheck weekly – retreat 2-3 times
8. Surgery

Accessing the middle ear by otoscopy and myringotomy is discussed above.

Sample Collection

In order to get a culture or cytology sample from the bulla in an ear without an eardrum, a sheathed catheter is used. With the closed irrigating ends removed, the 5 Fr. urinary catheter is first threaded through the external ear canal until it reaches the bulla. It should be inserted into the bulla along the floor of the horizontal canal and directed ventrally into the bulla. The sample is aspirated with a syringe or suction. If no liquid is in the bulla, 1cc of sterile saline can be infused and suctioned back. Any fluid or mucus that enters the lumen of the catheter is submitted to the laboratory for cytology and culture and sensitivity.

If a myringotomy incision was made with a sharp pointed 5 Fr. catheter, as the incision is made the catheter is extended into the bulla and the contents aspirated. The lumen contents are submitted to the laboratory. If a laser myringotomy was made, a sterile catheter is inserted through the hole and a sample is taken.

Cytology and Bacterial Culture

It is important to obtain samples for both cytology and bacterial culture. Many infections are polymicrobial including mixed infections of bacteria (rods and/or cocci) and yeasts. Cytology of a middle ear specimen may reveal *Malassezia* yeasts, which would not be reported if only bacterial culture was submitted to the laboratory. Additionally, cytology may not reveal bacteria because they are often protected from the cytology stains by mucus. Many cytology negative specimens have been reported as culture positive. In ear disease, laboratory assessment based on culture and sensitivity does not always correlate to clinical response (see below, systemic and topical antimicrobial therapy).

In cats with otitis media and polyps, the most common bacterial organism was *Staphylococcus intermedius*. Other bacteria have been isolated from cat middle ears including *Pseudomonas*, *Bordetella*, *Bacteroides*, *Fusobacterium*, and *Mycoplasma*. Fortunately, bacterial resistance problems are not usually a feature of feline otitis media. The most common microbes recovered from chronic otitis media in the dog include *Pseudomonas aeruginosa* and *Staphylococcus intermedius*. In one study, one or the other of these two bacteria was isolated in over 70% of the cases. Other isolates include *Streptococci*, *Proteus*, *Klebsiella*, *E.coli*, and some anaerobes. When microbiological samples from the middle ear were compared to the same bacterial isolates found in the horizontal canal, the antibiotic sensitivity of organisms isolated from the horizontal ear canal were different from the antibiotic sensitivity from organisms from the middle ear. This occurred in almost 80% of these cases.

Flushing and Suctioning the Bulla

Probably the most important technique for treating otitis media is flushing the bulla. Topical otic medications cannot penetrate through the thick exudate that fills the middle ear during otitis media, so this exudate and secretory material must be removed. Additionally, many destructive enzymes that are trapped in the mucoid secretions in the bullae remain in contact with the mucoperiosteum, which prolongs the disease. Hydrating the mucus with the water in flushing solutions makes it less dense and easier to suction.

Using fluid under pressure to irrigate the bulla will loosen mucus from the tissue. This material does not stick to the mucous membrane as cerumen sticks to the epithelium in the external ear canal. The fluid the author uses for flushing the bulla is warmed, very dilute povidone iodine solution in warm tap water. If there is an identifiable gram negative bacterial infection, warmed tris-EDTA is also infused into the bulla. Acidic solutions should be avoided in the middle ear to prevent pain and irritation. Using a device that delivers the fluid under high pressure allows the mucus and pus to flush out of the bulla either into the external ear canal, where it can be suctioned out, or through the auditory tube into the throat. The OtoPet Earigator (OtoPet, LLC, Potomac, MD) makes flushing and suctioning the tympanic bulla a simple, efficient procedure. A 5Fr. or smaller polypropylene catheter connected to the irrigation/suction unit is placed into the

2mm working channel built into the Video Vetscope. The entire cleaning process is observed on the video monitor. The catheter is advanced along the floor of the horizontal canal and is directed ventrally into the bulla. A less rigid red rubber feeding tube can be used for flushing, but it may collapse when used for suctioning. Without this equipment, catheter placement and evaluation of the efficiency of cleaning is hard to determine, but that should not deter the attempt to flush the bulla.

Bulla Infusion

Removal of the mucus and pus within the tympanic bulla during the treatment of otitis media allows topical medications to penetrate in and around the thickened, folded mucoperiosteum. The use of aqueous formulations of **non-ototoxic** topical antibiotics, steroids, or antifungals placed on the mucoperiosteum hastens recovery from otitis media. Topical levels of these drugs may be many times the level that can be achieved using parenteral therapy even when there is severe hyperemia of the mucoperiosteum. Antibiotic concentrations are high in inflamed tissues because the increased blood flow allows increased serum levels of antibiotic to perfuse the inflamed tissue. But even these levels may not achieve the MIC necessary to kill the bacterial target.

Infusing drugs into the bulla is an effective method of providing long acting high concentration effects. The tympanic bulla in the dog and cat is a deep blind pouch. When the bulla is filled with antibiotic, the fluid cannot escape easily. Because of the small diameter of the swollen auditory tube and its location high on the medial wall of the bulla, drainage from the auditory tube is unlikely. Depending on the amount of eardrum present, fluid has to traverse a jut in the petrous temporal bone, which forms the floor of the horizontal ear canal and extends into the bulla. Fluid escape from the bulla is difficult and requires severe changes in head position to allow drainage through the eardrum. If a myringotomy incision was made, it would be difficult for fluid to escape the middle ear because of the surface tension across the incision. There may be a small movement of the infused antibiotic solution into the external ear canal, which actually may be beneficial, but the majority of the topical antibiotic solution can remain within the bulla for several days after infusion.

The antibiotic, antifungal, or corticosteroid solution is infused into the bulla through a small catheter placed into the bulla until the fluid overflows into the external ear canal. During the first bulla infusion, less than 1cc of solution can be infused into the inflamed bulla. The entire procedure of flushing, suctioning, and bulla infusion should be repeated weekly during therapy. With each successive treatment, the mucoperiosteum should retract slightly, increasing the volume of fluid the bulla can accommodate.

Reduce Inflammation with Corticosteroids

Corticosteroids slow the intense inflammation and exudation found in middle ear disease. As described earlier, the mucoperiosteum undergoes severe pathological changes in response to inflammation. Corticosteroids can reverse some of the extensive inflammation that forms in the bulla, which enhances the ability of topically applied antibiotics to penetrate into the infected tissue. The tympanic cavity is crowded out by this hyperemia and proliferating granulation tissue, so the amount of free space within the bulla decreases. Reducing the inflammation helps this lining membrane retract back toward the bone, increasing the volume within the bulla. When the eardrum heals this space should refill with air.

Corticosteroids also reduce the amount of mucus produced in the bulla and decrease the viscosity of the secretions from the inflamed mucous membrane in the bulla. Changing the character of the mucus aids in its removal. Corticosteroids may also function in reducing the swelling in the auditory tube, increasing lumen diameter, which has the beneficial effect of offering limited drainage of mucus into the nasopharynx.

Aqueous topical corticosteroids such as dexamethasone sodium phosphate (4mg/ml) or a DMSO/Fluocinolone combination (Synotic, Ft. Dodge) may be infused through a catheter placed into the cleaned and dried bulla. These potent topical anti-inflammatories are not ototoxic. Other potent injectable topical corticosteroids are formulated with ototoxins such as benzyl alcohol or propylene glycol, or they are in suspension. These should not be used in the bulla.

If there is bacterial or fungal disease and the space in the bulla is needed for antibiotic or antifungal topical therapy, systemic corticosteroids may be used for a few weeks during the recovery phase of otitis media. High initial doses of corticosteroid are required, which mirror those used for other diseases such as inflammatory bowel disease. Patients should be screened for diabetes, hyperadrenocorticism, demodicosis, and potential pregnancy before using the high doses of corticosteroids. Prednisone or prednisolone at 1-2mg/lb daily for 2 weeks then decreasing to ½ mg/lb every other day will provide high enough levels to decrease inflammation within the bulla. Owners of these animals need to be warned that there will be side effects of prednisone at this high dose. Many owners will discontinue the medication when the side effects occur. The author prefers to use a 0.1 mg/lb intravenous dose of dexamethasone (2 mg/ml) at the time of treatment and then to repeat this injection weekly at the recheck appointment if there is significant exudate that needs to be suctioned from the bulla. This has less mineralocorticoid-related side effects and prevents the owners from having the choice to stop the medication. Because many dogs with otitis media also have concurrent otitis externa, systemic corticosteroids aid in reducing the swelling and pain from otitis externa. In addition, they reduce the signs associated with atopic disease, which is a primary cause of otitis externa in the dog.

In cats, the infectious organisms involved in otitis media can usually be treated with oral Azithromycin (Zithromax, Pfizer) at a dose of 5mg/lb. given every other day for 2-3 treatments or once a day for a week. This antibiotic has a high

affinity for respiratory tissue and will concentrate within the bulla. The aqueous corticosteroid is placed within the bulla instead of the antibiotic, as in dogs.

Systemic and Topical Antimicrobials

The dilemma facing the clinician treating otitis media is that systemic drug levels may not reach sufficient MIC in the bulla and topical treatment requires frequent applications. Using maximal doses of oral antibiotics alone is not usually sufficient for treatment of otitis media. Weekly bulla infusions of a fresh supply of topical antibiotic increases the therapeutic successes.

Topical antibiotic treatment of otitis media has gained recent favor in veterinary medicine. The use of topicals is based on the high levels of antibiotic that can be placed into the bulla coupled with the poor drainage of the tympanic bulla. Aqueous solutions of non-ototoxic antibiotics can be placed directly onto the infected mucoperiosteum. Infused antibiotics can remain in contact with the inflamed, granulating middle ear mucosa much longer because the fluid filling the bulla cannot readily escape. When topical therapy of otitis media fails it is usually the result of inability of the antibiotic to get to the bacteria. For example, there may be sequestration of bacteria within folds or pockets of granulation tissue, unexposed to the topical antibiotic.

Antibiotic sensitivity patterns are important for treating otitis media when systemic antibiotics alone are used to get levels within the bulla. Unlike topical antibiotics, which can achieve many times the blood MIC, systemic antibacterial therapy for otitis media relies on lower levels of antibiotics arriving in the middle ear hematogenously or through inflammatory cells. Due to the poor blood supply in the external ear canal and middle ear, there is limited diffusion of antibiotic from the serum into the lumen of the ear canal or tympanic bulla.

Rechecks

With successive recheck visits, the eardrum and the horizontal canal should be examined for fluid, mucus and pus. If there is fluid within the bulla, it should be flushed out and the bulla suctioned to prepare it for re-infusion. When the weekly examination reveals a dry canal and little liquid within the bulla, the inflammation and infection within the bulla has subsided. At this point bulla infusion treatments can be discontinued. Subsequent 2 week recheck intervals should reveal a healing eardrum.

Surgery

Medical therapy of otitis media in the author's practice is 75% successful. A small number of chronic otitis media cases with severe proliferative tissue and bone spicules require total ear canal ablation and bulla osteotomy in spite of proper medical therapy.